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**THE BEE-LOUSE, BRAULA COECA, IN THE
UNITED STATES**

E. F. PHILLIPS

Senior Apiculturist, In Charge of Bee Culture Investigations, Bureau of Entomology¹

CONTENTS

	Page		Page
Conditions in infested apiaries in Maryland.....	2	Number of Braula found on one bee.....	7
Description of the species.....	3	Perception of light by Braula.....	8
Classification of Braula.....	3	Remedies.....	8
Development of Braula.....	4	Conclusions.....	9
Geographical distribution.....	5	Literature cited.....	9
Feeding habits.....	5		

The announcement by the writer (32)² of the presence of the so-called bee louse, *Braula coeca* Nitzsch, in Carroll County, Md., where it has existed for several years, makes it desirable that information be available regarding the relationship of this species to the bee colony. There is nothing on Braula in the American literature except occasional notes on its introduction on imported queenbees with brief statements giving opinions of foreign beekeepers regarding it, usually without reference to investigational work. Even the foreign bee-keeping literature usually fails to include the results of scientific investigations on this species. It has therefore seemed best to summarize the work done, to ascertain to what extent the introduction of this species may be considered worthy of attention, and to list the pertinent literature cited.

The common name bee louse is not an especially appropriate one, since Braula is not a louse, nor does its behavior in feeding suggest even the loose use of that word as a common name. Since the name is well established in many languages, however, there seems no special necessity for protesting its use or of suggesting another common name for the species.

Braula has repeatedly been introduced into the United States on importations of queenbees from foreign countries, and in many cases no effort has been made by the recipients of these queens to remove

¹ Resigned October 25, 1924.

² Reference is made by number (italic) in parentheses to "Literature cited," p. 9.

the parasites before the introduction of the queens. Usually the parasites have disappeared promptly. Since more queenbees have been imported into the United States from Italy than from any other country, Braula is sometimes mentioned in the American literature as the "Italian bee louse." The carelessness of American beekeepers regarding Braula is doubtless due to presumably authentic statements to the effect that the permanent introduction of Braula into the United States is impossible, that it is confined to warm climates, or that it is a quite harmless species. Unless Braula is actually beneficial its introduction is not to be desired, for American beekeepers already have their full share of imported nuisances and pests in the various diseases of the brood and of adult bees, as well as recognized specific enemies of honeybees, all of which are, of course, importations. In addition to the occurrence of Braula in Carroll County, Md., it is also authentically reported to occur in a small area in south central Pennsylvania. Prof. A. D. Whedon, now at the North Dakota Agricultural College, Fargo, N. Dak., has kindly furnished the writer with a photomicrograph of Braula taken by him some years ago at Mankato, Minn., from bees located there. The extent and permanence of this occurrence of Braula are unknown. There is no record of importations shortly before these specimens were taken to explain their presence. Beekeepers who find any instances of the occurrence of this species in the United States will confer a favor by sending specimens and a history of the case to the writer.

CONDITIONS IN INFESTED APIARIES IN MARYLAND

The apiaries in Carroll County in which Braula has been found are under the management of successful commercial beekeepers who have watched this species for several years to determine whether it is damaging their colonies. They report that it does no damage to strong, healthy colonies in case it is found in them, and in this respect they agree with most European observers. Braula is here usually found on worker bees, rarely more than one to a bee, but under some circumstances they may collect in larger numbers on the queenbees. If, for example, an infested colony of black bees becomes queenless (perhaps in some cases because of the presence of Braula) and if then a young Italian queen is introduced, the insects collect in considerable numbers on the young queen and within a few months she may have the appearance and behavior of an old queen. In the brief examination made of this infestation one drone was found carrying a Braula. Although no thorough examination has been made of all the colonies in the infested apiaries, probably not more than 10 per cent of the colonies contain Braula, and it is noteworthy that some of the strongest colonies, and those producing good honey crops, are infested. These apiaries are as well managed as are most commercial apiaries and can not be classed as badly managed. The results as measured by the honey crops are good, and it is not the belief of the owners that Braula is reducing the honey crop. There are many poorly kept apiaries in the neighborhood, however, in which the presence of Braula might show a different result.

DESCRIPTION OF THE SPECIES

Braula coeca is a wingless, reddish-brown insect having a length of about 1.5 millimeters and a width of about 0.75 millimeter, males being somewhat smaller, on the average, than females. The entire body is covered with numerous stiff, spinelike hairs, at least some of which are said by Massonnat (28) to be connected with nerve endings. These hairs are especially numerous on the head, except on the clypeus and the lower side of the head. The head is flattened from front to rear and is oriented vertically on the thorax, bringing the mouth parts toward the ventral surface of the insect. The antennae have a peculiar structure and are articulated in a deep fossa on each side of the head. Eye rudiments are present, but there are no ocelli. The thorax is discoid and very short on the dorsal surface and is inserted throughout its width on the abdomen. There is no trace of either wings or halters. The legs are of equal length and are long in proportion to the size of the insect. The last tarsal joint of each leg carries a remarkable chitinous comblike structure, divided in the middle with 15 or 16 teeth on each side of the median line, these being modified claws. These combs are serviceable in permitting *Braula* to attach itself to the branched hairs of its host, which is especially necessary for an animal living on a rapidly moving and flying insect like the honeybee. Each terminal tarsal joint also carries two pear-shaped pulvilli of delicate structure, covered with fine hairs. The abdomen has five visible segments and occupies about 60 per cent of the whole length of the body. It is cylindrical in general shape, tapering to the posterior end, and is flattened less than in most Pupipara. The abdomen of the female when eggs are in formation is terminated by a transparent prolongation in which have been recognized the rudiments of three additional segments, but unless eggs are being formed these segments are invaginated.

Braula is found only on honeybees, although there are statements in the literature that it occurs on bumblebees, doubtless due to incorrect identification of parasitic species thus observed.

CLASSIFICATION OF BRAULA

This insect was first described by Réaumur (33) who briefly discusses the species and its relation to the bee colony. The genus and species were described by Nitzsch (30) who gave the name *Braula coeca*, classified it with the Diptera on account of the structure of the mouth parts, and allied it with the Pupipara. Various discussions have appeared regarding the exact classification of this species in the series of Diptera of the group Pupipara, and Egger (15) erected for it a special family, Braulidae. Egger corrected certain erroneous statements made by Nitzsch regarding the structure of the antennae and thorax and thereby removed the last doubt as to the alliance of *Braula* with the Diptera. Müggenburg (29) shows the relationship of *Braula* to the Hippoboscidae in the structure of the head vesicle. Until recently the position of *Braula* with the Pupipara has not been seriously questioned, although, as will be explained later, *Braula* is not pupiparous. Bezzi (?) was the first taxonomist definitely to remove *Braula* from the Pupipara and he places it as a

subfamily of Phoridae. Dr. J. M. Aldrich is of the opinion that it is better left as a distinct family near the Phoridae.

The synonymy of *Braula* is not complicated. Costa (13) gave the species the name *Entomobis*, evidently not knowing of the work of Nitzsch. Bigot (8, pp. 227, 235) suggests that the name of the genus might more appropriately be *Melitomyia*, as better describing the habit of the species, and later in the same paper the spelling *Melitomya* occurs, but only the first spelling would stand in the synonymy. This latter name is derived from the Attic Greek name, *melitta*, for the honeybee, as distinguished from the word *mellissa* used by the other Greeks. Since Bigot offers this merely as a proposed synonym for *Braula*, it need not be discussed further. Fabricius (16) erroneously placed the bee louse in the genus *Acarus*, based on the figure given by Réaumur.

It is usually stated that there is but one species of *Braula*, but Arnhart (3), in an effort to explain the diversity of statements regarding its developmental stages, raises the question whether there may not be more than one species. Schmitz (34) has described a new species, *Braula kohli*, on African honeybees, but no work has been reported on its development. De Miranda-Ribeiro (27) gives a half tone of the species found in Brazil, in which the head appears to be relatively much narrower than in the European species, and which may be another species; but this, after careful examination, is denied by Lima (22). Schmitz calls attention to the variation in the number of teeth in the tarsal combs as described and figured by various authors, but since at least some of these illustrations are merely the result of careless drawing it is not well to depend too implicitly on such evidence. The existence of several species of *Braula* would scarcely be adequate to reconcile the variety of statements which have appeared regarding its development.

DEVELOPMENT OF BRAULA

Until recently it was generally supposed that *Braula* is pupiparous, although as early as 1858 Leuckart (21) pointed out essential differences between the organs of the female of this species and those of *Pupipara*, and Müggenburg (29), a pupil of Leuckart, states that "Professor Leuckart believes, as he has kindly told me, that the eggs of *Braula* have occasionally been found in the cells of the bee comb." Skaife (35) described the eggs, larvae, and pupae of *Braula coeca* and for the first time definitely showed that the species is not pupiparous. His conclusions (35, p. 48) are:

Braula coeca is oviparous, not pupiparous, as was hitherto supposed. The eggs are deposited on the brood combs in the hives, hatch out into typical muscid larvae which make their way into cells containing young bee larvae. The larvae feed on food supplied to the brood by the nurse bees, and beyond robbing the bee larvae of a little of their food do no harm. The larvae pupate inside the cells beside the bee pupae; they emerge before the bees do and make their way at once on to the bodies of their hosts. The adults feed on honey, probably supplied to them by their hosts.

An important addition to our knowledge of the breeding behavior of this species was made by Arnhart (2), who shows that development takes place on the under surface of the cappings of honey in the brood combs in special wax tunnels prepared by the *Braula* larvae. Müggenburg states that he has never found a larva in the

sex organs of the female and further states that the gland tubes which serve to furnish food for the developing larvae of species of *Pupipara* are lacking in *Braula*. Skaife confirms Müggenburg in this point.

The material collected in Carroll County, Md., contained plenty of adult insects, and under cappings of the honey in the brood combs were found eggs, larval skins, and pupae clearly identical with those described by Skaife and in the exact position described by Arnhart. The puparium of *Braula* is not hard, but consists of the last larval skin unthickened; it is not brownish in color as stated by Assmuss (4). Lósy (23, 24) states that copulation of *Braula* occurs on the queenbee.

GEOGRAPHICAL DISTRIBUTION

Braula occurs in France, Italy, Germany (but not in Hanover and Oldenburg, according to a private communication from Dr. H. v. Buttel-Reepen), and in the Baltic region, according to Assmuss (4). It is also recorded in Further Pomerania by Timm (36), in Mediterranean countries by Benton (5), on the island of Cyprus by Cook (12), on the authority of Benton, in South Africa by Skaife (35), in Brazil by De Miranda-Ribeiro (27), in the Argentine Republic by Wolff-hügel (38), in Austria by Arnhart (2), in Holland (34), and in Czechoslovakia (Dr. A. Schönfeld in a private communication). It is reported by Assmuss not to occur in northern, middle, or southern Russia, and by Gale (17) as absent from Australia. Cheshire (10) states that it has been introduced into England, but that it rarely survives a winter there. From these records it is evident that the statements which have frequently occurred in American beekeeping literature to the effect that *Braula* is confined to warm climates are not correct.

FEEDING HABITS

The question of first importance regarding *Braula* is its exact relation to the bees on which it lives, and the best evidence on this point seems to be the information regarding its method of taking food. Frequent statements have been made to the effect that it takes its food by sucking the blood of the bees on which it lives (5, etc.), and it is frequently mentioned as a parasite. Other writers have referred to it as a commensal of the colony, some of them (35) stating that it lives on honey. The older writers as a rule considered it a true parasite. The tongue of *Braula* has been carefully described by Lósy (23, 24) and by Massonnat (28), who show that the tongue is incapable of piercing the integument of the bee or even of puncturing between the chitinous plates of the abdomen. There are no hard stylets on the proboscis, so that it is evident that in taking food *Braula* must confine its attention to some source other than the blood of the bees.

The behavior of *Braula* in feeding has been described by various investigators and the description by Pérez (31) is frequently quoted. The original paper has unfortunately not been available to the writer but at least a portion of his results have been translated by Root (31) and are quoted below.

One day, having captured a bee with one of these lice, I fixed its head with a pair of pincers sufficiently to keep it unmovable, and to capture the small parasite easily. Both it and the bee were left for a while on the table in my studio, under glass.

When I returned to them I was not a little puzzled to see the parasite in the most vivacious and strange agitation. Seated on the fore part of the bee's head it was moving about with incredible vivacity, as though possessed of veritable rage. Now it would go to the margin of the bee's cap, with its fore feet raised, stamp and scratch as hard as its weakness would allow at the base of the bee's lip; then it would suddenly run back to the insertion of the antennae to renew its impetuous attack immediately. I was quite taken up by my first surprise, when I suddenly saw all this fury turned to perfect calmness, and the little animal squatted on the edge of the cap and bent down its head to the bee's mouth, which was slightly trembling, and sucked up a drop of moisture.

I instantly understood. The movements I had just witnessed were preparatory to the animal's meals. When the louse wishes to feed it goes to the bee's mouth, where the motions of its feet, armed with bent claws, produces a tickling sensation, perhaps disagreeable to its host, but at least provoking some movement of the buccal organs, which slightly open and release a small drop of honey which the louse at once licks up.

Thus the *Braula coeca* is not a real parasite of the bee in the true sense of the word. It is rather a guest—queer, if you like thus to consider it, like so many others existing among animals.

Lósy (23, 24) has studied the mouth parts of Braula in detail as well as the feeding habits. His two papers are in Hungarian, but a good review by Gorka (24) gives what appears to be the essential part of his results. Since this review is important, the main parts are here freely translated:

The parasites are mostly on the queen and first go over to the workers when they undertake the feeding of the larvae, when Braula nibbles at the food which is conveyed to the brood. As soon as this feeding is ended they are all found on the queen, on which mating also occurs. Their number by the end of November becomes so great that the queen is in danger and she becomes weakened and in late fall she perishes. In greater degrees of infestation (in unclean colonies) this may occur even in summer, and may result in the death of entire colonies. * * * The mouth parts of Braula form a sucking organ which is adapted to the mouth parts of the bee in an astonishing manner. * * * The bee louse sucks its nourishment from the outstretched mouth parts of the bee. It perceives the stir which occurs from the movement of the chitinous parts of the skeleton during sucking, which tells it that it can again enter the mouth parts of the bee. Then it quickly runs over the back of the mouth parts as the bee holds out its tongue for the sucking of food, sucks up and swallows the food, or if food is allowed to drop into the cells of brood Braula takes the sweet food arising from the glands of the bee. The bee louse remains standing on the open jaws and the upper lip, and when the jaws of the bee are about to be separated its sucking organ is opened. This separation is assisted by the Braula so that it wedges with brushlike bristles in between the mouth parts of the bee and separates them, then it stretches out its proboscis and reaches it to the back upper surface of the tongue. As soon as the tongue of the bee is in motion, the horizontally held beak of the Braula proboscis reaches into the cavity at the base of the bee tongue which is then brought forward. Here it is pinched under the paraglossa, is broadened, its bristles are ruffled up, and with the two supporting bristles of the lower lip it spreads the paraglossa of the bee apart and in this way it not only prevents the drawing back of the tongue, but it also holds the basal part of the tongue open. This occurs for the reason that beneath the base of the tongue the external opening of the canal from the salivary gland is found. Through this gland opening, because of the irritation of the unusual penetrating body and the unusual saliva, saliva is poured forth reflexively, which the Braula sucks up. * * * Braula is therefore a parasite which has become adapted to the organism of the queenbee and is a burden and torture of the first order to them.

In the examination of Braula from Maryland, smears were made of the contents of the alimentary canal, and in one individual 11 peculiarly shaped pollen grains were found, while in the alimentary canals of the bees from which the Braula were taken pollen from the same plant source (unidentified) were abundant. Whether pollen is an important constituent of the diet of Braula is not known and it may have entered merely in association with liquid food taken in the

way described by Lósy. The liquid portion of the diet could not be identified from the smears.

It seems to be almost the unanimous opinion of beekeepers of European countries that *Braula* occurs in weak colonies and especially in those not properly housed and cared for. It is also stated (20) that it is more abundant in poor seasons. Emphasis is always placed on the necessity of keeping the hives, and especially the bottom boards, clean, and obviously these precautions are not taken except by the best beekeepers. The question arises, therefore, whether the weakness of colonies containing *Braula* is the cause or result of the infestation. If we look on *Braula* merely as an undesirable commensal, its damage would probably be slight, although the bees usually seem to make little effort to remove it. If it is actually, as claimed by Lósy, a parasite of highly specialized habit, then it may be a dangerous parasite to the welfare of the colony. Since in the one case where this insect has been observed in the United States it does not seem to be causing much damage, the extreme view of Lósy would not seem to be supported,

An interesting discussion of *Braula* in the infested areas is given in a private communication (January 12, 1924) from Dr. Ludwig Arnhart of the Österreichische Imkerschule, Vienna, who says in part:

As far as my own experience and knowledge go, *Braula* becomes harmful only if found in large numbers in the hive. A single one will not injure the queen, the worker, or the drone. The last is attacked the least. They are most frequently found on queens, which are weakened to a great extent by large numbers of these lice and perish easily during the winter season.

NUMBER OF BRAULA FOUND ON ONE BEE

It appears that usually there is not more than one *Braula* on each worker bee, although there may be more on the queen bee, if, as described by Lósy, there is a migration from the workers to the queen at the close of brood rearing. This might partially account for the wide discrepancy in the reports on this subject. Assmuss (4) states that in his experience there is usually only one to a bee, but that they may occur in much greater numbers. They occur on workers, drones, and especially on queens. Hammer (18) reports taking 187 *Braula* from a queen and at a later date 64 from the same queen. Cheshire (10) reports removing 6 from a queen in England; Cook (12) reports that Benton has taken as many as 10 from a single bee; Kramer and Theiler (20) report that as many as 60 have been taken from a single queen; Benton (5) reports having removed as many as 75 from a queen at one time "although ordinarily the numbers do not exceed a dozen"; while Marboud (26) reports that he took off 31, the next day 33, two days later 43, and continued until he had removed a total of 371.

Timm (36) questions the accuracy of these extravagant statements. The bee louse is relatively large in proportion to the size of the honeybee and it would seem impossible for a queen to carry such great numbers as those reported. He expresses the belief that these observers have mistaken either mites or triungulin larvae of *Meloë* for *Braula*, although there would seem to be little excuse for such an error. It is certainly the case that *Braula* usually occurs singly on

worker bees and that if larger numbers occur it is almost exclusively on queens. In Maryland two Braula have not been observed on a single worker and they are rare on the queens, except under the conditions previously described.

PERCEPTION OF LIGHT BY BRAULA

The specific name *coeca* was given this species by Nitzsch on the assumption that it is blind. Müggenburg (29) points out that—

it is not blind, for despite the previous statements, it has two small eyes which lie above the antennae. From their situation these eyes represent the compound eyes of the Diptera. Their dioptic apparatus is only very slightly developed. The chitin of the head covering over the place in question is thinner and transparent * * * and shows no trace of facet formation. Ommatidia are not found under the imperfect cornea. From sections we perceive, as in early developmental stages of insect eyes, a mass of hypodermal cells which show a tendency to radial arrangement. Pigment is not present. However, a thin optic nerve extends to this rudimentary eye from the supra-oesophageal ganglion which increases near its connection with the same to a small ganglion.

Massonnat (28) describes this eye structure in still more detail and figures the various internal parts, but, unlike Müggenburg, he claims to find traces of pigment. Timm (36) also describes the presence of eyes. Von Buttel-Reepen (37) pointed out to beekeepers the incorrectness of the statements that Braula is blind, but this same error has since been repeated in more recent beekeeping papers. No physiological work has been reported to determine whether Braula actually responds to light stimuli.

REMEDIES

It is commonly stated in European beekeeping literature that Braula occurs in weak and badly managed colonies, especially in those the hives of which are not kept clean. If these statements are correct, preventive measures would seem to be of far greater importance than methods for the removal of Braula. Various methods are given for its removal. An early method was to pick them from the queens by means of a feather, some suggesting first dipping it in honey to cause them to adhere well. Arnhart (2) uses small pointed sticks dipped in honey in the same manner. It is also recommended (6) that the queen be removed from the colony and gently smoked with tobacco smoke, which causes the stupefied Braula to drop off, after which they may be destroyed, and since she will probably collect more when returned to the hive, it is usually recommended that this be repeated at intervals. This method has its faults, since the smoking of the queen may cause the bees to ball her when returned. The placing of a small bag of naphthalene on the bottom board of the hive is said (11, 19, 25) to cause the insects to drop from the bees to the bottom board, from which they should then be removed before any of them recover. Smoking with saltpeter or Lycopodium, old methods for stupefying bees, have been recommended (9), as well as oil of turpentine (19) on a cloth on the bottom board, carbolic acid (14) similarly used, and incense powder (11), these all being used because Braula apparently succumbs to such fumigation before the bees do. Zander (39), however, points out that naphthalene may not only dislodge the Braula but may also drive the bees

from the hive. Since there may be developmental stages not affected by the first treatment, the operation should, after an interval, be repeated to remove those which in the meantime have reached the adult stage.

A safe method has just been recommended (1) which if satisfactory has more in its favor than the methods just suggested. This is that, since weak, listless colonies are the ones which harbor Braula, the infested colony should be opened in the evening and sprinkled thoroughly with honey water. Then, in cleaning up the dilute honey, the bees are said to remove the Braula. None of these methods has as yet been tested in the United States.

CONCLUSIONS

It appears from the available information that Braula is not a serious pest of the apiary and that no great harm is to be anticipated from its unfortunate establishment in this country. It is, of course, not certain that it will remain here. This introduction, however, should not be considered as unimportant, and wherever Braula occurs steps should be taken to eradicate it from the infested colonies. With such a visitant of the bee colony, it is impossible to determine in advance what effect it may have in some other portion of the country, and every means should be taken to eradicate it if possible, especially since the infested area seems to be small at present. Inspectors of apiaries who find this insect in colonies inspected by them will do well to recommend its removal. More work is needed on the life history and especially on the feeding habits of the species.

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